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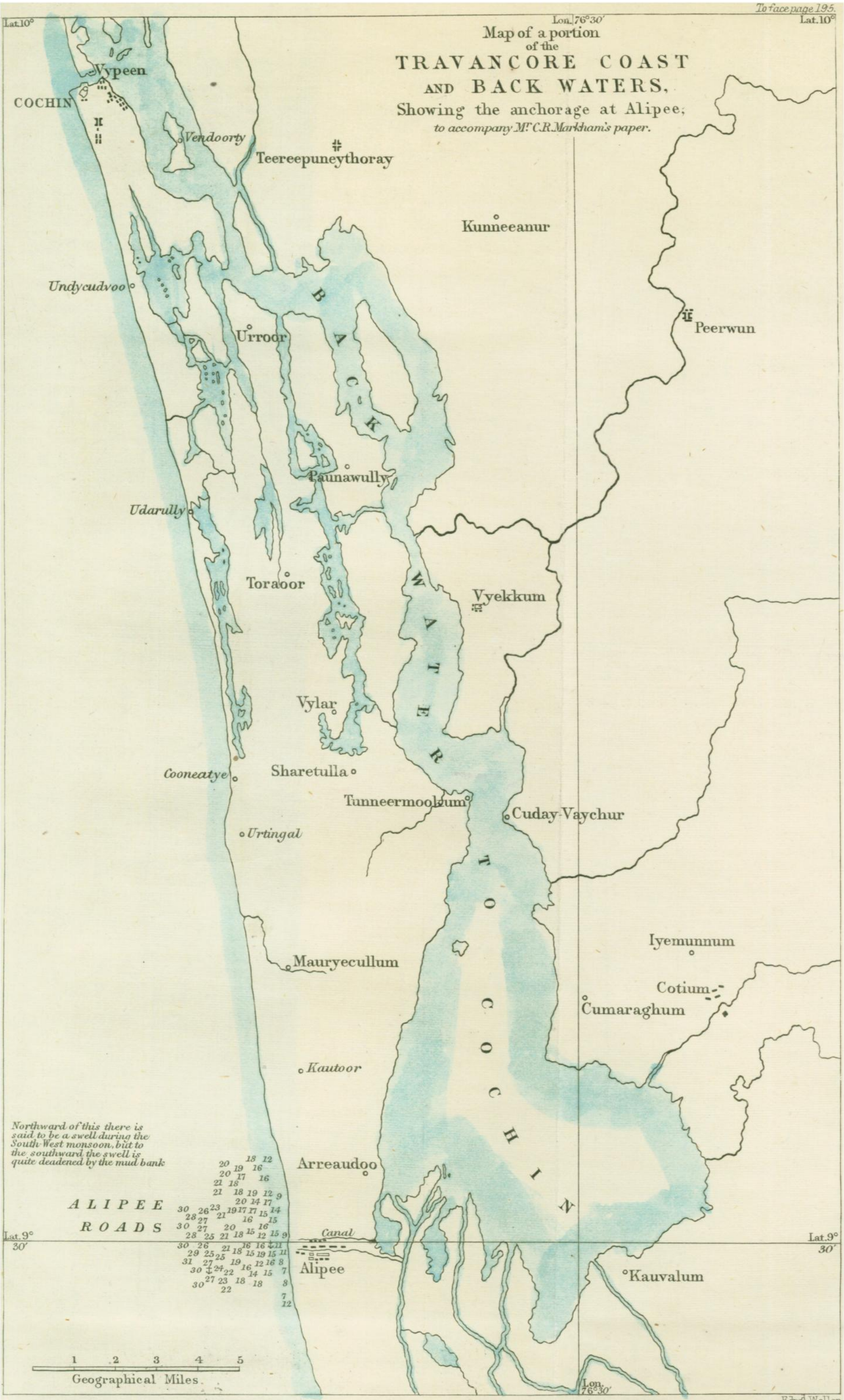
effects from the same causes on the island of Curaçoa. General Baker has observed these results in the country to the westward of Hissar in northern India, and Mr. Fox Wilson has given us an interesting account of the desiccation of the basin of the Orange River. The whole subject is very ably discussed by Mr. George P. Marsh, in his work on 'Physical Geography, as modified by human action.'

XII.—*On the Inland Navigation of Travancore; an Account of the Alipee Mud-bank and the Wurkallay Barrier.* By C. R. MARKHAM, Esq., F.S.A., Secretary R.G.S.

Read, January 28, 1867.

THE Malabar coast country, including Cochin and Travancore, is furnished by nature with a highway which traverses nearly its whole length. The backwaters, which form this water communication, are continuous from Trivanderum to the railroad at Ponany, except at one point; and the completion of this grand system of inland navigation, by cutting through the single barrier, is most urgently required. I had the opportunity, in my journey through Travancore, in December, 1865, of examining this barrier.

But before describing the Wurkallay Barrier, it will be useful to explain the natural causes which have given rise to the mud-bank of Alipee—a phenomenon as curious as its effects are useful. At no very distant date, geologically speaking, the sea appears to have washed the base of the ghauts. Two points ran out for a considerable distance, one of which is now represented by the Wurkallay Barrier, the other by a ridge of laterite, to the northward of Cochin. A wide bay intervened; and the well-known Hindoo tradition relates how the sea was made to recede and leave a home for the Namburi Brahmans. Without doubt alluvial deposits gradually encroached upon the sea, which were checked by the waves of the monsoon, and eventually a belt of land was formed between the backwaters and the sea, now densely covered with cocoa-nut groves. This belt forms the present sea-coast; and at one point the famous mud-bank of Alipee, the chief port of Travancore, affords safe anchorage. The whole roadstead has a remarkably soft muddy bottom; and the fluidity of the water being diminished, while its activity is deadened by the accession of mud, the anchorage is very smooth in 4 fathoms, even while the swell of the monsoon is at its height in the offing. The mud-water extends from the beach to the anchorage, a distance of about 2 miles; and it is very curious that while the mud-anchorage always remains in the same place, the line of mud-water moves up and down the coast with the anchorage as a pivot, from about a



Map of a portion
of the
TRAVANCORE COAST
AND BACK WATERS,
Showing the anchorage at Alipee;
to accompany Mr. C. R. Markham's paper.

Published for the Journal of the Royal Geographical Society by J. Murray, Albemarle Str.t, London, 1866.

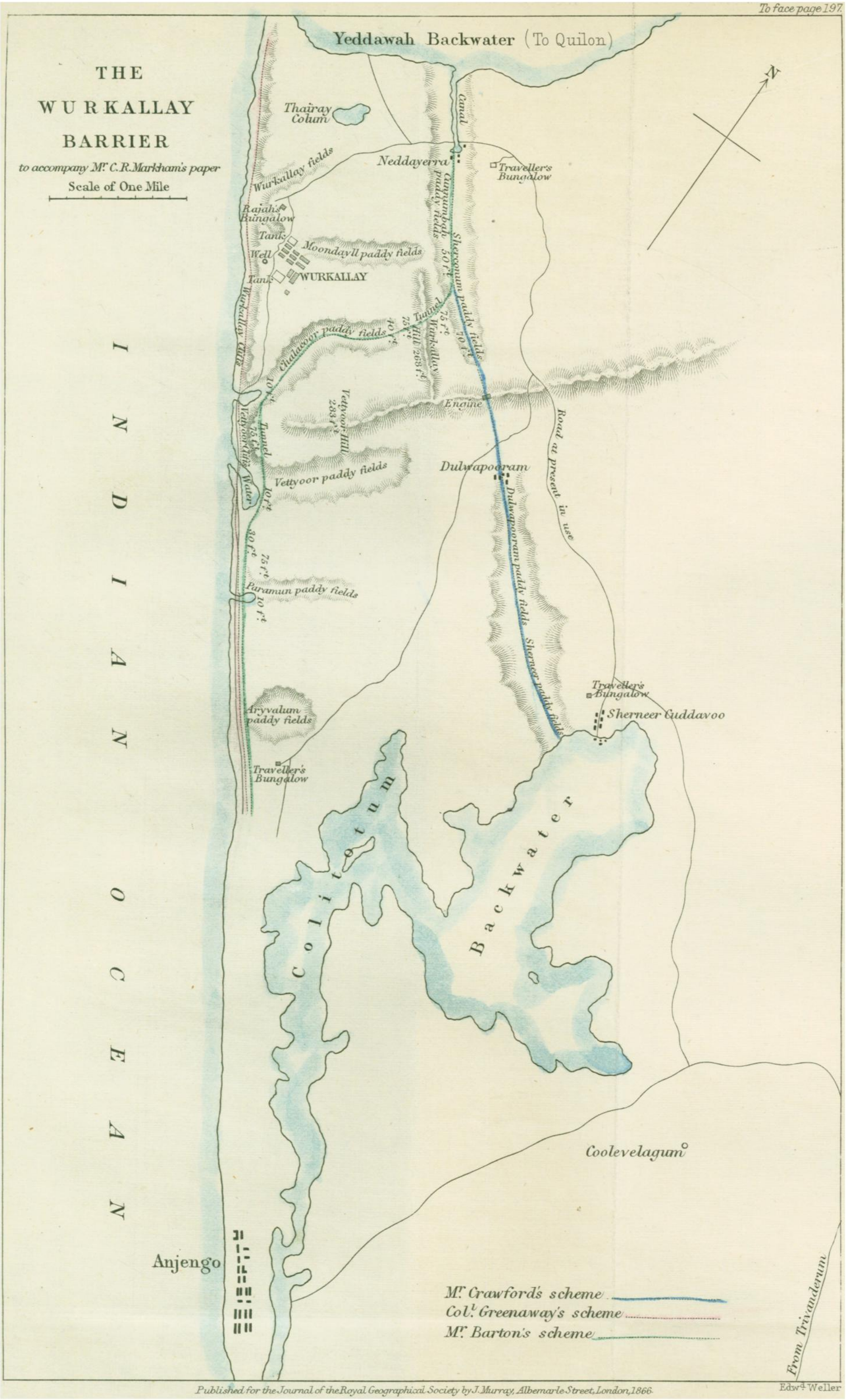
Edwd. Weller.

mile south of Alipee to 2 miles north of that port—the movement occupying a period of several years.

The causes which have formed this mud-bank, and thus afforded by far the safest roadstead in these seas, are, I think, explained by the observations which have been conducted, with much care and intelligence, by Mr. Crawford, the commercial agent of the Travancore Sirkar. The usual explanation is, that the bottom happens to consist of soft mud off Alipee, which is stirred up by the waves of the monsoon. This, however, is quite inadequate to account for all the phenomena of the mud-bank; and I am inclined to believe that the theory formed by Mr. Crawford, after a series of experiments, is the correct one.

During the height of the monsoon the waters of the backwater are 4 feet higher than those of the ocean, and an enormous hydraulic pressure must thus be caused. In the same season, at low water, a series of mud-volcanoes are observed to form on the beach, which eventually burst and disgorge quantities of vegetable matter, and even cocoa-nut stems mixed with mud. On boring to a great depth on the belt of land between the sea and the backwater, the instrument passed through alluvial deposit into apparently moving soft mud, the pressure on the boring instrument being strong to seaward. These facts point to the conclusion that there is a subterraneous communication, through mud, between the backwater and the sea; and that the tremendous pressure at the season when the waters of the backwater are higher than those of the sea, forces an immense mass of mud mixed with vegetable matter, by a subterraneous channel, into the roadstead, where smooth water is thus caused. In this manner Travancore commerce finds a safe oulet. Alipee is approached from the backwater by a canal bordered with houses and cocoa-nut groves, which is crossed by six timber bridges, having streets leading to them at right angles with the canal—a sort of Indian Venice. At the end of the canal is the house of Mr. Crawford, who has long and ably conducted the commercial affairs of the Travancore Government, the custom-house, the great Sirkar timber-yard, and the salt, tobacco, and cardamom godowns. There is also a well-built light-house with a flash-light, and a tramway from the beach to the town. Alipee is now a very important place, and is becoming more so, while Cochin is falling into decay. The whole of the increasing trade of Travancore passes through Alipee, and it has a large trade with Calcutta and Bombay. Cochin, on the other hand, is losing much of its trade, and its ship-building business has been destroyed by the coasting steamers.

The inland navigation of Travancore is formed by connecting the backwaters by canals. One of these—11¼ miles long—from the Channankarry Backwater to Trivanderum, was made by the



THE WURKALLAY BARRIER

to accompany Mr. C. R. Markham's paper

Scale of One Mile

Published for the Journal of the Royal Geographical Society by J. Murray, Albemarle Street, London, 1866.

Edwd. Weller

Dewan Vencata Row, between 1823 and 1826, at a cost of 10,712*l*. Others connect Quilon with the backwaters to the north and south, and were executed between 1826 and 1829. These canals are full of shoals deposited from the paddy-fields, and boats drawing 1 foot often have to be dragged over shallows for considerable distances. A small expenditure and more systematic supervision are much wanted. But the grand problem is the Wurkallay Barrier, which cuts the inland navigation of Travancore into two sections.

The Wurkallay Barrier, immediately to the north of the old English factory of Anjengo, is a spur of the ghauts extending to the sea, and consists of a ridge of laterite hills about 6 miles broad, with a summit-level of 180 feet. The spur ends abruptly in a line of cliffs washed by the sea. The high land is covered with grass and flowering shrubs, such as *Ixoras* and *Osbeckias*, with some crops of gram and other dry cultivation, and a few clumps of jack and mango-trees. On the south side of the spur is the Colitotum, on the north the Yeddawah Backwater. From the Colitotum Backwater a ravine runs up to within half a mile of the summit of the ridge. This ravine is covered with paddy cultivation, called the Sherneer and Dulwapooram fields, and is lined with cocoa-nut trees, jacks, and plantains. From the Yeddawah Backwater a canal is brought up to a place called Neddayerra, where another ravine runs up the Barrier to within half a mile of its highest part. This ravine is also entirely occupied with rice cultivation, called the Cunnumbah and Sherconum fields. An excellent road now crosses the Barrier to the east of these ravines, from Sherneer to Neddayerra; and there are travellers' bungalows at both these places. The cliffs are of soft laterite, and contain a remarkable deposit of lignite. These cliffs are intersected by five ravines covered with paddy cultivation, called, respectively the Wurkallay and Moondayll, the Chalacoor, the Vettyoor, the Paramun, and the Aryvalum fields. These ravines slope down gradually from the higher ridge of the Barrier. The village of Wurkallay, containing a pagoda, tank, and Rajah's bungalow, is near the cliffs towards the north end of the Barrier.

There are four distinct plans for cutting through the Wurkallay Barrier and, by connecting the Colitotum and Yeddawah backwaters, completing the system of inland navigation in this part of India.

The first of these projects is advocated by Mr. Crawford, of Alipee. He proposes that the Dulwapooram and Sherconum ravines should be formed into regular inclined planes. A stationary engine would then be placed on the summit between the two ravines, working running gear. Loaded boats would be placed on trucks running up and down the inclines on tramways, and the engine would haul them up one side and lower them down the other, without breaking bulk—thus passing them from Sherneer to the head of the canal at Neddayerra, and *vice versâ.*

The second scheme is that of Colonel Greenaway, the late engineer in Travancore. He proposed to bring a canal along the foot of the cliffs from one backwater to the other by blasting the cliffs back to a distance of 50 feet, and constructing a sea-wall from the débris. This, however, is said to be impracticable. The sea is already washing away the cliffs, and their decay is accelerated by numerous springs in their rear.

The third plan is to make cuttings up the Sherneer and Sherconum ravines, and a tunnel through the hill which divides them. The highest parts of the ravines are 70 feet above the backwater, so that the cutting would have to be that depth.

The fourth plan is recommended by Mr. Barton, the present Travancore engineer, and has been adopted by that Government as likely to lead to the most successful results. He proposes to continue the present canal, on the northern side of the Barrier, from Neddayerra, by making a cutting in the Cunnumbah and Sherconum paddy-fields, nearly to the head of the ravine, where the depth of the cutting would be 50 feet. He would then make a tunnel under the Wurkallay Hill, from the Sherconum ravine to that of Chalacoor. The hill consists of sand and clay (full of springs), and rests on a base of limestone; and there will be great difficulties in making this tunnel. The canal will thence be brought by a cutting along the Chalacoor ravine, nearly to the beach. It is then to pass through another tunnel under the Vettyoor Hill to the Vettyoor paddy-fields, where the cliffs cease; and there is no further difficulty in excavating a canal thence to the Colitotum Backwater, close to Anjengo. It will be a very difficult and costly undertaking; but when once completed, it will be of permanent value, for the trade carried along the backwaters is large and increasing.

XIII.—*Exploration in East Africa between* 14° *to* 16° N. *Lat.*

By COUNT C. VON KROCKOW.

THE district which I have explored in East Africa is bounded on the north by the Chor el Gash, on the south by the River Setit, on the west by the River Atbara, and on the east by the land of the wild Bazen.

In 1864-65 I started from Kassala, and travelled southward through the region which in the German maps is designated as the "Land der Schangalla" (Land of the Shangalla). The Arabs call it "Baraka," or "Barka" (which means lowland).